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ABSTRACT

Operating grants to provincially assisted universities in Ontario are based on a formula that is derived from a system of weights assigned to various categories of student enrollment. This formula, however, cannot be used both for emergent universities and established institutions. There is probably no substitute for subjective decisionmaking, within a limited time, until a new university's special needs are reduced to a point where the institution can go on standard formula. The present report is an attempt to sketch some guidelines for determining a point of emergence and to propose a grant formula that might serve as a guide in establishing grants to emerging universities. (For related document see also HE 003546.) (HS)

August 28, 1967.

REPORT TO THE COMMITTEE OF PRESIDENTS OF UNIVERSITIES OF ONTARIO

A FORMULA FOR OPERATING GRANTS TO EMERGENT UNIVERSITIES AND EMERGENT COMPONENTS OF ESTABLISHED UNIVERSITIES

Submitted by the Sub-Committee on the Financing of Emergent Universities

INTRODUCTION

Operating grants to provincially assisted universities, beginning with the 1967-68 academic year, are based on a formula devised jointly by sub-committees of the Committee on University Affairs and the Committee of Presidents.(1) The scheme is based on a system of weights assigned to various categories of student enrolment ranging from a base unit of weight one to a weight of six for advanced Ph.D. students. Students in all years of general arts and general science are given a weight of one unit and other courses and graduate work are scaled to reflect the relative costs involved in the whole spectrum of university teaching tasks.

It was agreed that there was merit in the early introduction of a formula scheme while at the same time it was recognized that modifications would likely occur as experience was gained in the first few years. Of Ontario's fourteen universities, eight were considered to be sufficiently established to "go on standard formula" (Toronto, Western, Waterloo,

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(1) Report to the Committee on University Affairs, a Formula for Operating Grants to Provincially Assisted Universities in Ontario submitted by the Sub-Committee on Finance of the Committee on University Affairs, 1966. (D. T. Wright, Chairman).

Queen's, Ottawa, McMaster, Carleton, Windsor), while six were judged to be in an emergent status requiring financial consideration beyond the standard formula (Brock, Trent, Lakehead, Laurentian, York, Guelph). Scarborough and Erindale, while part of the University of Toronto, are considered emerging components of established institutions.

In the report on the standard formula it was recognized " . . . . . that the same formula cannot be used both for emergent universities and established institutions. There is probably no substitute for subjective decision-making, within a limited time, until a new university's special needs are reduced to a point where the institution can 'go on standard formula'. It must be born in mind, however, that the emergent situation cannot go on indefinitely."

The present report is an attempt to sketch some guidelines for determining a "point of emergence" and to propose a grant formula which might serve as a guide in establishing grants to emerging universities.

THE EMERGENT STATE

While there has been general agreement with the concept that in the founding years of a university special financial considerations are required, it has not been clear how to translate this qualitative judgment into the quantitative realities of year-to-year operation and forward planning. It is recognized that the present standard formula and the value of the basic income unit at any time are meant to accommodate the "normal" expansion of universities in their established programmes and, as well, to allow for the generation of new directions and special options within the general framework of existing studies. However, even in established institutions on standard formula the introduction of new programmes of the scope of Law, Medicine, Architecture, Library Science, Forestry, etc., would appear to require special consideration.

Some of the factors contributing to higher costs during emergence are outlined below as a background to establishing a guideline "formula for

emergence".

(a) The general academic goal and broad philosophy of education to be undertaken by a new university are perhaps the most important factors to be considered in its founding years. To define a "point of emergence" in terms of enrolment scale or academic viability one must characterize the nature of the educational programme which is expected to emerge, e.g. diversity of studies, honours programmes, professional schools, graduate work, patterns of attendance.

Not unexpectedly, new universities sense needs of freshness of approach, of academic innovation, of concern for student life and of sparkling high ideals. A careful study of the financial implications of some of the educational goals must be undertaken before an understanding can be reached on financial support by government. Going "on standard formula" implies that innovation in the academic process is constrained within the limits of the basic unit grant, unless specific private support is available.

The calibre of the initial staff in a new institution will depend largely on the academic philosophy expressed by the institution and its general prospect for development as a centre for serious and advanced study. The early introduction of graduate work in at least a few fields thus becomes an essential condition for research-minded faculty members -- but it is a costly undertaking. And yet, if graduate work is not begun for, say ten or fifteen years, then its introduction becomes, for academic reasons, the more difficult at the later time.

(b) The student-faculty ratio for an emerging institution is of necessity lower than the ratio for established institutions, which is currently about 12 - 15 in Ontario. Ratios of 8 - 10 must be expected in earlier years for several reasons: faculty members must devote a good deal of time to academic and general planning; early classes are likely to be small, even if a new university spanning the normal range of arts and science subjects in about 12 - 15 disciplines can begin with 500 - 600 first-year students. Indeed, one of the costliest procedures, in terms of per student operating costs, for

starting a university is to begin with only about 100 students. To "begin with a small class" in makeshift quarters, while satisfying the desire to get underway, builds into the ensuing cost pattern a considerable burden for several years. However, the careful planning and development which this makes possible may result in important economies in both capital and operating costs in the future.

The cost per faculty member, including benefits, immediate support staff, etc., is approximately $15,000 per annum as outlined in the model attached as Exhibit 1 to this report. Thus at a student-faculty ratio of 10 the "professorial" cost per student is $1,500 and with only general arts and science students this is also the cost per unit. Even at a ratio of 15 the cost per student, or per unit, is $1,000 regardless of the size of the enrolment in general arts and science.

(c) Library resources are items of expenditure now universally included in operating grants under the present formula. Recent reports, e.g. "Spinks" report, have commented on the urgent need in Ontario universities generally to build up library holdings to adequate levels as quickly as possible. The necessary expenditure on library books, and the attendant processing costs of approximately equal amount, places a large burden on per-student costs in the early years. Thus an institution acquiring about 25,000 to 30,000 books per year at a cost of say $250,000 plus an equal processing cost of $250,000 will have to spend $1,000 per student at an enrolment of 500 students, and even at 2,000 students the cost would be $250 per student or per unit.

(d) Scientific equipment for on-going teaching purposes has recently been designated by the Province as an operating cost. In the past, Ontario universities have acquired equipment from capital, operating, and research funds and it is therefore difficult to arrive at historical standards for the purchase of new equipment by emerging institutions.

Assuming, however, that equipment costs might approximate library book purchases, an expenditure of $250,000 per year might be considered

reasonable. At enrolments of 500 and 2,000 students this results in costs of $500 and $125 per student or per unit.

(e) Administration and Plant Maintenance: Administrative costs in the early years of development form a significant percentage of total costs. It is usually desirable to hire a nucleus of senior administrative personnel at the outset as a base for future growth. The younger university must carry out the same administrative functions as the more advanced and "departments" are usually required for President, Vice-President, Comptroller, Registrar, Student Affairs, Personnel, Placement, Development, Public Relations, etc.

Plant maintenance costs will vary markedly from year to year depending on the extent to which construction is completed for future development. The acquisition of basic maintenance equipment, the development of an Engineer's Department, Campus Planning, Ground Maintenance and Security Staff are as essential to the emerging institution as the emerged.

In the early years of development these costs may run as high as 30% of total costs and will gradually decrease as enrolment rises. Based on previous data, costs per student or per unit range from $1,200 for 500 students to $800 for 2,000 students.

(f) A summary of these costs at 1967-68 dollars is set out below based on general arts and science enrolments of 500 (at a student-faculty ratio of 10) and 2,000 (at a student-faculty ratio of 12) students respectively:

Total Cost per Student	Enrolment 500	2,000
Professorial	1,500	1,250
Library	1,000	250
Equipment	500	125
Administration	500	350
Plant Maintenance	700	450
	$4,200	$2,425

DISCUSSION

Thus the emergent state of new institutions or indeed of new major programmes in established institutions can be analyzed in terms of some of the major components of their operating costs and a relationship derived which can rationalize the cost of emergence.

Each of the emergent universities; Brock, Trent, Lakehead, Laurentian, York, and Guelph, as well as Toronto's Scarborough and Erindale Colleges agreed to submit for purposes of analysis within the sub-committee, details of operating expenditures as submitted on page 1 of UA 4 forms for the years 1966-67 and their projections for 1967-68, as well as enrolment data and student-faculty ratios. The major cost components derived above have been constructed from an analysis of these figures.

In the earlier stages of the sub-committee's discussions the question was raised as to whether a mathematical formula approach was possible for the emergent institutions or whether individual year-by-year presentations and judgments were required.

The presently emergent universities do indeed differ markedly. Brock and Trent are completely new universities beginning with the basic range of undergraduate studies in arts and science which for general coherence requires teaching in about fifteen to twenty subjects. Scarborough and Erindale are Colleges of the University of Toronto and can depend on the resources and established prestige of the parent institution as well as on the obvious capacity of such a system to shape the growth rate curve effectively. Lakehead, quite remotely located from the major centres of Ontario's population, began as a technical college and will experience a different kind and rate of growth than might be possible in "the deep south". Laurentian is a bilingual university planning to operate in several locations. Guelph, while one of the oldest institutions in the Province, has recently been transformed into a more general campus with emergent components -- and furthermore, an experiment in "tri-mester" operation is underway. York, already a two-campus institution,

is faced with a rapid expansion programme with a high growth rate and plans to enter a wide variety of studies. These and other factors will probably require, into the foreseeable future, special financial consideration.

Amid such wide diversity, it is possible that eight different detailed formulations for emergence will be the only solution. However, even as the standard formula encompasses a wide diversity of cost ratios in a standard weighting system it was hoped that a reasonably simple and universally applicable formula could be devised as a guideline to emergence.

After a great deal of discussion and analysis it was agreed that, to provide reasonable financial constraints on emerging institutions, to seek a "point of emergence" beyond which standard conditions will apply, and to provide a base for future planning, the construction of a simple formula as a guide to emergence would serve a useful purpose. A base would thereby be established for estimating total financial implications for the Province and each university could then plan its programme accordingly.

It is conceivable that special circumstances which reflect a desirable diversity among institutions will on occasion result in requests for special consideration. Those needs cannot be rigorously formulated a priori and some flexibility must be retained in the shaping of young universities. As institutions "emerge" and become larger and more complex such flexibility can become internalized -- but in early stages of development internal degrees of freedom are too few and reasoned judgment must play an essential role.

A quantitative formulation to be used as a guide for financing institutions during emergence has been developed and is attached to this report. It is based on two separate analyses: (a) the construction of hypothetical models at various sizes of institution using "reasonable" expenditures for the major components, at 1967-68 costs; (b) the projection of actual historical data for the emerging institutions. These analyses should enable an understanding to be reached for at least the coming three years.

CONCLUSIONS

The fundamental presupposition in our consideration has been that Ontario's system of higher education should strive to retain its traditions of high quality and build strong academic centres, well prepared for the expected tripling of university enrolment in the next fifteen years. The present level of graduate enrolment, about 10,000, is expected to reach about 30,000 by 1980. Second-rate institutions will not be able to effect the necessary transformation in the coming decade.

1. (a) Under the present standard formula the emergent state of a university of reasonably good academic quality in arts and science disciplines may be expected to last until the number of basic income units equals at least 4,000 and possibly 5,000 - 6,000 depending on complexity.

   (b) Should a university remain below about 4,000 units or as other special conditions warrant then a supplementary grant beyond the standard formula is required indefinitely if a good standard is to be maintained.

2. The unexpectedly high "emergence point", in 1 (a) above, reflects the restraint imposed by the low value ($1,320) of the basic unit for 1967-68, even though it may be an appropriate base for calculations involving the presently emerged universities, whose average ratio of Basic Income Units per student is 1.75 and hence receive an average operating income of $2,310 per student.

3. The total cost of emergence for a new university, beyond that allowed under the present standard formula will depend on the rate of growth, but as a rough estimate a total of about $10 million over a period of 8 - 12 years appears to be required.

4. Emergent components of established universities, e.g. Law, Dentistry,

Medicine, Library Science, Architecture, or special arts and science campuses such as Erindale, Scarborough or Wellington College, could be treated under the general formula proposed in this report. It would be necessary, however, to determine for each instance and within the specific context an appropriate emergence point for each of such components.

The co-effecients in the proposed formula for emergence are to a large extent determined by the weighting scheme and basic unit value of the standard formula. A review of the emergence formula is required should any changes in the standard formula occur.

RECOMMENDATIONS

The sub-committee recommends:

1. That a formula for emergence to be used as a guideline as defined in this report* be approved in principle by the Committee of Presidents.
2. That the sub-committee on Formula Financing undertake joint discussions with the appropriate sub-committee of the Committee on University Affairs and determine a final formulation acceptable to both the Committee of Presidents and the Committee on University Affairs.

* See pages E-3, E-4, E-5 .

Sub-Committee on the Financing of Emergent Universities:

T. L. Batke (Waterloo) - Chairman
J. E. Leishman (Trent) - Secretary
* G. O. B. Davies (Brock)
J. B. Millward (Guelph)
D. W. Morgan (Lakehead)
R. A. Nairn (Brock)
C. Nurmi (Laurentian)
B. Parkes (York)
D. Jean (Laurentian) - Visitor
E. H. Sharpe (Guelph) - Visitor
G. Thompson (Lakehead) - Visitor
B. Hansen (Toronto) - Visitor

* It is with regret that we must record the untimely death of Dean Davies on March 10, 1967. He contributed greatly to the Sub-Committee's discussion at its earlier meetings and he himself displayed the intellectual qualities so vital to attract in emerging universities.

EXHIBIT I: A GUIDELINE FORMULA FOR FINANCING EMERGENT UNIVERSITIES

(A) PRINCIPLES E - 1

(B) PROPOSED FORMULA

- ALGEBRAIC E - 3
- GRAPHICAL E - 4
- TABULAR E - 5

(C) HYPOTHETICAL MODEL AS A FORMULA BASIS E - 8

(D) HISTORICAL-MATHEMATICAL ANALYSIS AND COMPARISON E - 17

(A) PRINCIPLES

The following principles were used in arriving at a quantitative formulation of a simple method of financing emergent institutions.

1. The basic operating income for emergent universities, or agreed upon components of universities, should be related to the scale of development as measured by basic income units, (B), rather than to a time scale of a certain number of years.

2. The point of emergence, $(B)_x$, at which the standard formula begins to apply to an institution should be defined in terms of a number of basic income units appropriate to the range of studies or programmes under consideration. A value of $(B)_x = 4000$ is used in the formula presented here as a reasonable minimum for arts and science studies.

3. The concept of "allowed grant units, (A) is introduced as a means of calculating the operating income for emergent institutions, in place of (B) for the emerged institutions. The proposed formula, then, establishes a quantitative relationship between (A) and (B).

4. The mathematical form of the proposed formula for emergence, and values of the coefficients, were arrived at under the

following considerations: (a) a simple relationship is desirable rather than an elaborate equation with a dozen or more parameters attempting to define each element of cost; (b) historical data on the evolution of young institutions were used to determine the range of major cost components; (c) a cost-study model for academic and economic viability was used to enable some "anchor points" of the formula to be evaluated.

While some further analysis is required, it is possible that the same type of formula may be applicable to emergent components of universities, whether or not the university is considered emerged or emergent at any time. Agreement would have to be reached that a proposed development ought to be so defined, and, that an appropriate value of the emergence point, within the specific context, can be arrived at. Such individual judgment is desirable so long as a suitable analysis forms the framework of discussion.

(B) PROPOSED FORMULA

(A) = Allowed Grant Units

(B) = Basic Income Units as Calculated by Standard Formula

$(B)_x$ = Basic Income Units at Point of Emergence to Standard Formula

FOR ESTABLISHED UNIVERSITIES OR PROGRAMMES (A = B)

(Basic Operating Income) = (Basic Income Units) x (Unit Value)

= (B) x (U)

FOR EMERGENT UNIVERSITIES OR PROGRAMMES (A > B)

(Basic Operating Income) = (Allowed Grant Units) x (Unit Value)

= (A) x (U)

$$(A) = f(B)$$

PHASE 1 $\quad (A) = \frac{(B)_x}{8} + 2(B) \quad$ Where $0 < (B) \ll \frac{(B)_x}{4}$

PHASE 2 $\quad (A) = \frac{(B)_x + (B)}{2} \quad$ Where $\frac{(B)_x}{4} \ll (B) \ll (B)_x$

AFTER EMERGENCE $\quad (A) = (B) \quad$ Where $(B) \gg (B)_x$

NOTE: $(B)_x$ To be determined for individual cases

(U) = Basic Unit Value, $1320 for 1967-68

FIG. 1 - GRAPH OF FORMULA FOR EMERGENCE

PHASE 1 $(A) = \frac{(B)_x}{8} + 2(B)$

PHASE 2 $(A) = \frac{(B)_x + (B)}{2}$

$(B)_x = 4000$

STD. FORM. $(A) = (B)$

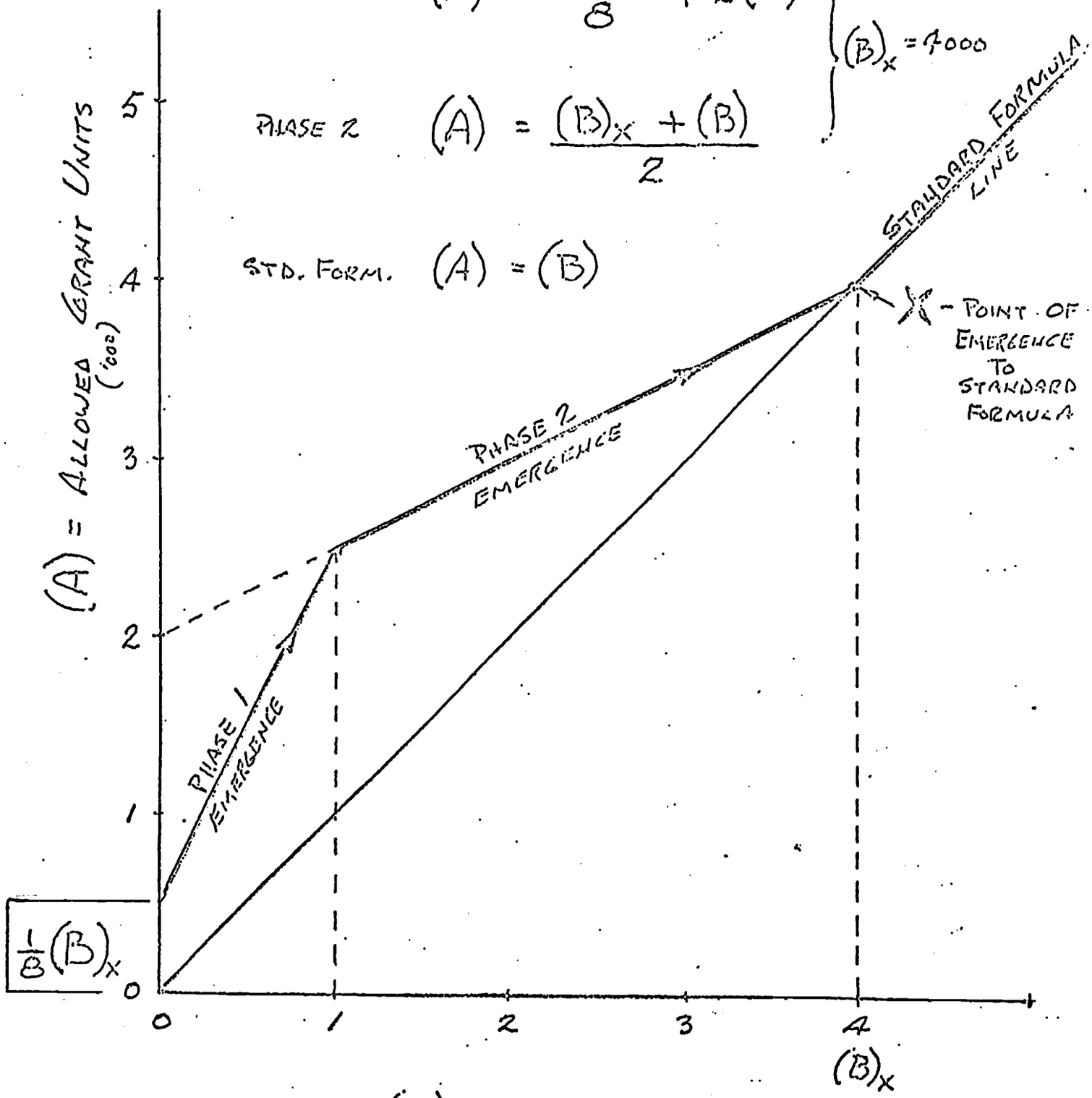


TABLE 1 - FORMULA VALUES FOR $(B)_x = 4000$

(B) Basic Inc. Units	(A) Allowed Grant Units	(A)/(B) Ratio	Equivalent "Allowed" Unit Value 1967 ($)
200	900	4.50	5,940
400	1300	3.25	4,290
600	1700	2.83	3,736
800	2100	2.63	3,472
$1000 - 1/4\ (B)_x$	2500	2.50	3,300
1200	2600	2.16	2,851
1400	2700	1.93	2,548
1600	2800	1.75	2,310
1800	2900	1.61	2,125
$2000 - 1/2\ (B)_x$	3000	1.50	1,980
2500	3250	1.30	1,716
3000	3500	1.16	1,531
3500	3750	1.07	1,412
$4000 - (B)_x$	4000	1.00	1,320

FIG. 2 - COMPARISON OF PROPOSED FORMULA WITH CURRENT GRANT SITUATION

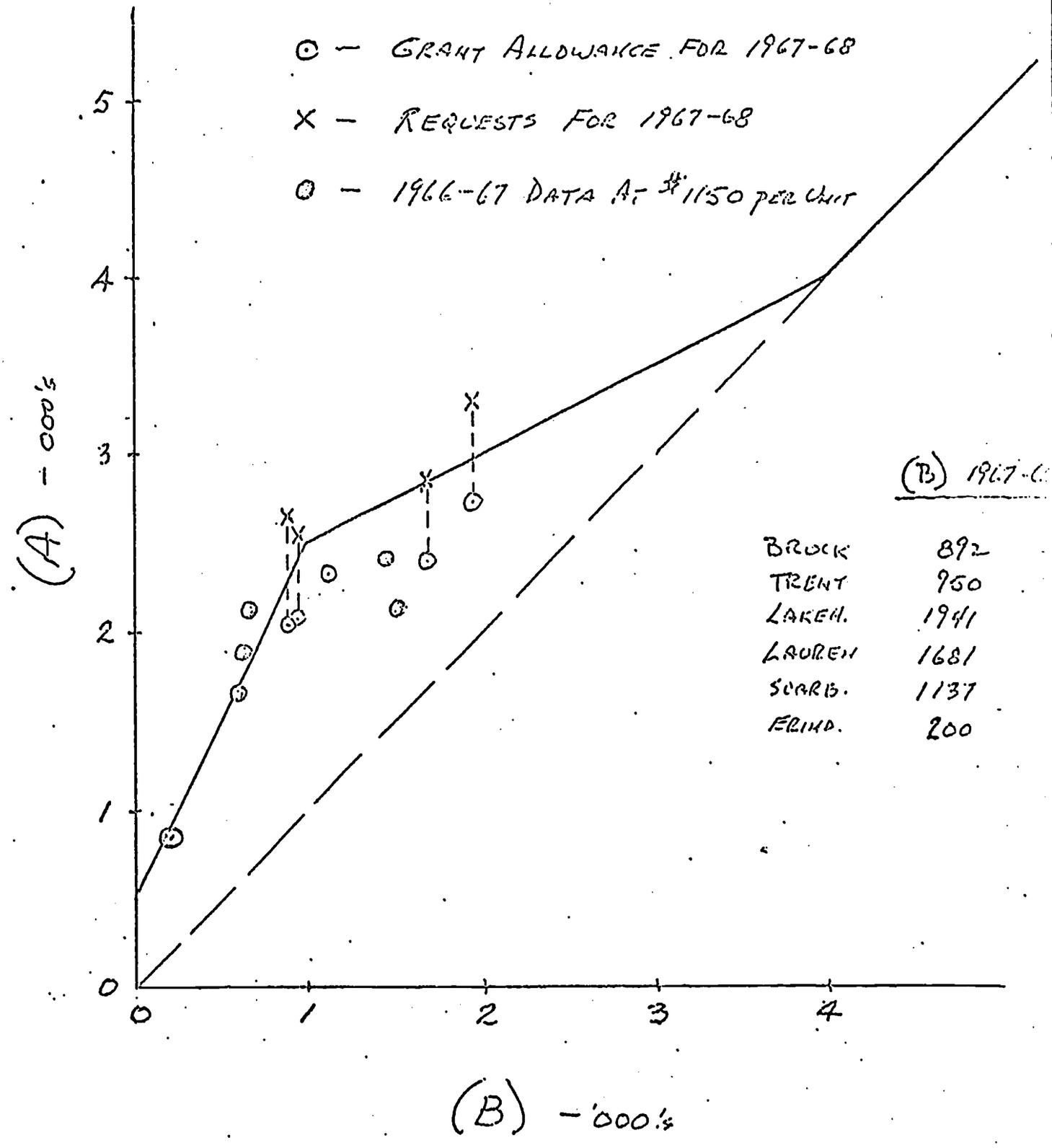
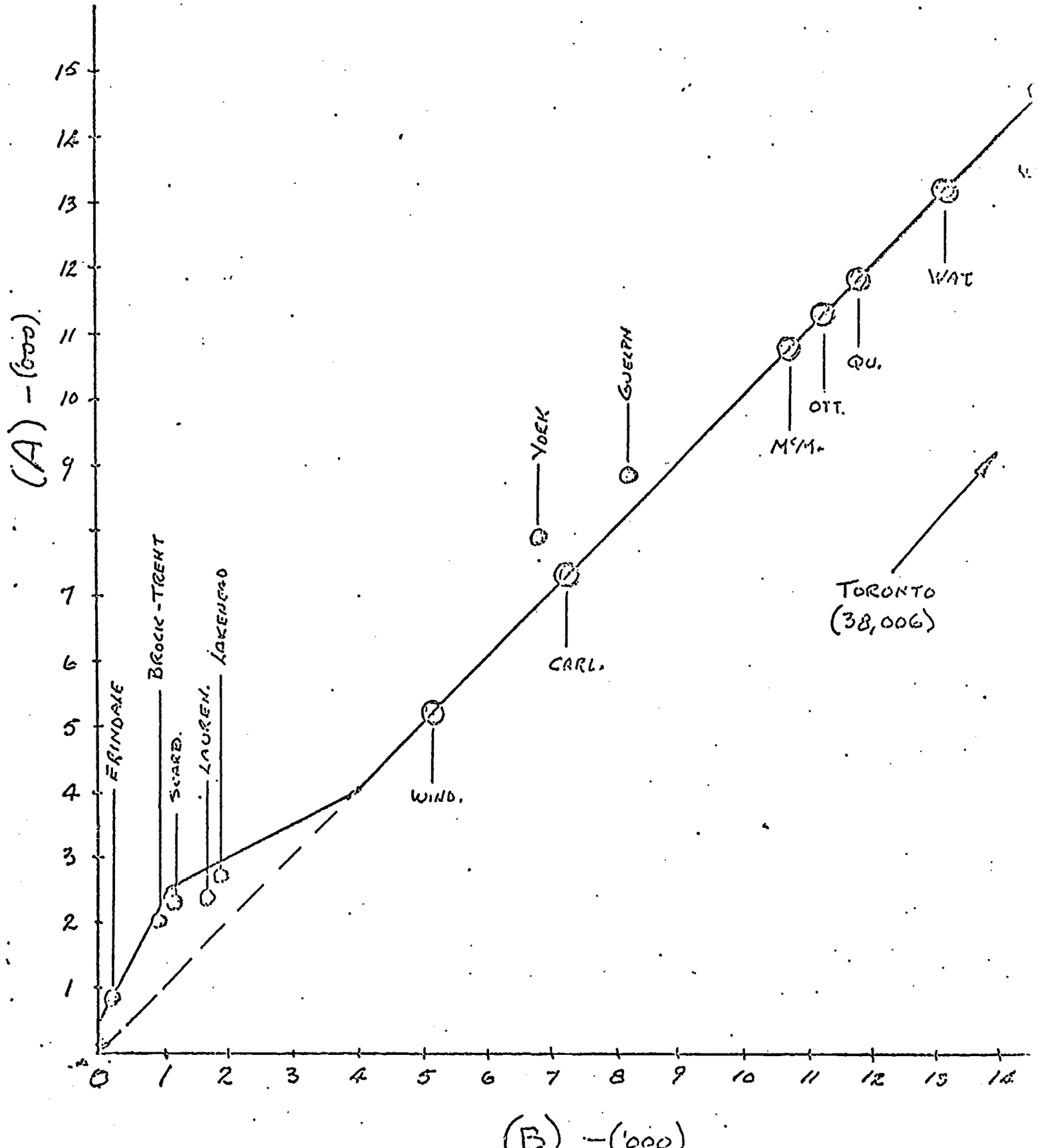


FIG. 3 - COMPARISON OF ESTABLISHED AND EMERGENT INSTITUTIONS



(C) MODEL FOR AN UNDERGRADUATE ARTS AND SCIENCE UNIVERSITY OF 2000 STUDENTS

Since there exist, especially in the United States, liberal arts and science colleges of enrolment ranging from about 1200 to 2500 students, and many of them of excellent quality, it can be reasonably assumed that a college or small university of 1500 - 2000 enrolment is academically viable. That is to say the central academic disciplines can be explored and the number of faculty members available in any one area is such that a reasonable range of specialization is possible and a sound context for study can exist. The best of such colleges have good libraries, well equipped laboratories and a student-faculty ratio of about 8 - 10. Some determined selectivity in areas of special emphasis is required or else costs would become prohibitive, and enrolment, by sheer academic momentum, would rise to the inevitable level of a fully developed graduate school.

The model to be developed here is of more modest concept. Thus it may be assumed that a student-faculty ratio of about 14 - 16 is possible at an enrolment of 2000, even though at 500 - 1000 students a ratio of 10 is desirable, especially in a state of moderately rapid growth. It may furthermore be assumed that a basic library of, say, 150,000 volumes is available and that it will grow at the rate of 25,000 - 30,000 volumes per year in a

period when enrolment grows at about 200 - 400 students per year. General administrative costs are rising because of the increasing burdens of our developing "communications culture" -- endless studies, analyses, reports, briefs, conferences, and meetings appear to be required, as well as "social services", ranging from student aid administration, physical and mental health and counselling problems to "sit-ins" and "be-ins" on university government and related problems. In a new university mechanization and computerization for all manner of information storage and transfer, while required for conformity to province-wide "systems", is of necessity at a less-than-optimal economic scale. All of these activities are probably worthy -- but costly.

The following simple cost model is based on current costs at average provincial levels. The concept of devising a model arose with the assumption that an enrolment of 1500 - 2000 students in general arts and science could produce a viable scale at which the transition to "standard formula" was possible. As will be shown however, the conclusion is reached that although an institution may be academically viable, economic viability at $1,320 per basic income unit is unlikely for an institution of 2,000 students unless a drastic change in the quality of the academic process occurs.

It is difficult to escape a second conclusion: that the presently used standard formula, giving a weighting of one to general arts and science students, while possibly applicable to these courses as they are carried

on in the context of a large and complex university, is not applicable even at apparently academically viable institutions that concentrate their efforts on these studies, as younger institutions are likely to do.

The following assumptions are used in arriving at the per-student or per-unit costs for a developed arts and science institution with an enrolment of 2,000 students:

1. ACADEMIC DEPARTMENTS (15)

English	Economics	Mathematics
History	Political Science	Physics
Philosophy	Psychology	Chemistry
Classics	Sociology	Biology
French		
German		
Spanish		

2. ENROLMENT DISTRIBUTION

			Gen.	Hon. Arts	Hon. Sc.	
(i)	Year I	750	600	75	75	
	Year II	600	480	60	60	
	Year III	550	450	50	50	
	Year IV	100	-	50	50	
		2000	1530			470 (23.5%)

(ii)	Year I	800
	Year II	625
	Year III	575
		2000

Note: If enrolment of 2000 is all general studies as in (ii) then (B) = 2000 ; if some honour's work is in progress as in (i) then (B) = 2240.

3. PROFESSORIAL COST (Including Benefits and Services)

Average Salary	$12,000
Benefits (7 1/2%)	900
Clerical (1 in 7)	550
Technicians (1 in 10)	550
Clerical-Technical Benefits	70
Travel	100
Sabbatical Allowance (5%)	600
Dean's Office ($40,000/133 Fac.)	300
	$15,070 ≈ $15,000

4. STUDENT-FACULTY RATIO - COST

S/F Ratio	No. Faculty Per 2000 Students	Cost Per Student = $15,000 / S/F Ratio
8	250	$1875
10	200	1500
12	166	1250
14	143	1071
15	133	1000
16	125	938
18	111	833
20	100	750
24	83	625

5. LIBRARY COSTS

- Assume at 2,000 enrolment a library of 150,000 vols. exists
- Assume library additions at 25,000 - 30,000 vols. per year

Book Costs = $250,000 (approx.)

Libr. Staff Cost = $250,000 (approx.)

$500,000

∴ Per-Student Cost - $250

6. EQUIPMENT - TEACHING & RESEARCH

- Assume equal to library book costs

∴ Per-Student Cost = $125

7. ADMINISTRATIVE AND PLANT MAINTENANCE COSTS

The sum of these costs, and including the costs of Registrar's Office, etc., which was not considered above, was arrived at from available data for emergent universities and some established universities. For an institution of 2,000 students a cost per student of $600 is justifiable.

(d) DISCUSSION

Thus without any more detailed analysis than shown here, it is possible to arrive at a per-student cost for a 2,000-student university doing only arts and science undergraduate work, possible with some honours courses, and assumed to have respectable academic standards, at a 15/1 student-faculty ratio.

Total Cost Per Student:

Professorial Cost	$1,000
Library Cost	250
Equipment Cost	125
Adm. & Plant Maintenance	600
	$1,975

If all of the 2,000 students were enrolled in general arts and science the standard formula would yield, for 1967-68 a per-student income of $1,320. The presently proposed formula would yield an income of $1,980 (i.e. 1.5 x $1230) and meet what is considered here as a reasonable per-student cost.

This analysis forms the basis of determining one of the "theoretical" points on the graph of the proposed formula.

The result, i.e. that 2,000 students, and reasonable academic viability does not allow economic viability with respect to the current basic unit value of $1,320, leads naturally to the question: "At what stage does an institution reach a point of emergence to standard formula?"

(a) If we assume that the institution grows to 4,000 students in general arts and science, then we find that it is still impossible to go on standard formula while retaining a 15:1 student-faculty ratio and expending no more on library, equipment, and administration than at the 2,000 student level.

Thus:

Professorial Cost	$1,000
Library	125 *
Equipment	65 *
Adm. & Plant Maintenance	300 *
	$1,490

* Note: The $300 figure above is probably unrealistically low. These costs are simply one-half the costs used for 2,000 students.

(b) It is much more reasonable to assume that by the time an institution reaches an enrolment beyond 2,000 it will have begun to do some honours work and begin some graduate work at the Master's level. Thus one may assume that at 3,200 students, the standard formula would generate, say, 4,000 basic income units (i.e. 1.25 basic income units per full-time students).

Thus:

Professorial Cost (at 15:1)	$1,000
Library	155
Equipment	75
Adm. & Plant Maintenance	420
	$1,650

In this model the per-student cost is $1,650 and the per-student income under the standard formula is also $1,650 (= 1320 x 1.25) and thus a possible emergence point at 4,000 units is arrived at. It must be noted however that the per-student expenditures are still low in comparison to the requirements for healthy development.

Similarly, another "theoretical" point, at 1,000 students, may be calculated.

Thus:

Professorial Cost (at 9:1)	$1,666
Library	500
Equipment	250
Adm. & Plant Maintenance	900
	$3,316

The proposed formula would yield a pre-student income of $3,300 (1,320 x 2.5) for this scale. Obviously in this range the individual institutions would differ greatly, e.g. their rate of growth and student "mix" may be such that special conditions arise.

It is instructive to examine the range of constraints imposed by a $1,320 unit value for an institution of 2,000 students in general arts and science. In the following examples emergence at 2,000 is assumed:

	A	B	C
S/F Ratio ⟶	11.36	20	24
Professorial Cost	1320	750	625
Library	-	120	245
Equipment	-	50	50
Adm. & Plant Maintenance	-	400	400
	1320	1320	1320

Model "A" represents a university, with a good student-faculty ratio, stripped to the barest minimum -- students and faculty meeting on logs in an open field. Models "B" and "C" illustrate that a student-faculty ratio of 20-24 would be required to maintain a minimal expenditure on library, and general administration.

Obviously there are many possible modifications -- for example, "cheaper" average faculty could be used by depending more heavily on junior lecturers.

The crucial point is that, with such meagre resources, a significant university centre is not likely to develop. This is of course a conceivable position to maintain. It is true that a "college" could be on standard formula at 1,000 or 2,000 units but it would inevitably become characterized as a kind of "senior high school" and indeed might serve a useful function. The general question of whether Ontario should consciously develop such institutions is of course a valid one and should clearly be settled. This issue was not considered to be within the terms of reference of the sub-committee (cf. p. 3, "The general academic goal ..."). We have attempted to provide a formula for the emergence of significant centres of learning.

(D) HISTORICAL-MATHEMATICAL ANALYSIS AND COMPARISON

This section sets forth the mathematical and statistical analysis underlying the development of a formula for financing emerging universities. Analysis of historical data for development of correlation and regression coefficients is considered first followed by the rationale for building the formula.

Historical Analysis

The first phase of historical analysis was to collect comparative statistics of government grants to selected new Ontario universities and subject these data to correlation and regression analysis. The data for this phase of the analysis were taken from information furnished as support material for a presentation by Scarborough College to the Committee on University Affairs in support of their request for operating funds for 1967-68. Table 2 presents the data that were extracted from this support material. The government grants shown as (Y) in the last column of Table 2 were adjusted by a factor of 7% to 1966-67 dollars.

The coefficient of correlation was computed to be 0.96 indicating high positive correlation between numbers of students and adjusted government grants. Next, a least squares best-fit line for the data was constructed as the equation

$$Y = a + bX$$

Where

Y = Adjusted government grant

a = Value of the Y intercept when X equal zero

b = Slope of the line

X = Number of students

TABLE 2

University	Year of Operation		Students (X)	Adjusted Government Grant (Y)
Brock	1	(64-65)	124	439,000
	2	(65-66)	361	730,000
	3	(66-67)	533	1,558,000
Trent	1	(64-65)	102	518,000
	2	(65-66)	85	743,000
	3	(66-67)	515	1,455,000
York	1	(60-61)	73	423,000
	2	(61-62)	216	625,000
	3	(62-62)	305	1,036,000
Scarboro	2	(66-67)	502	1,607,000
	3	(67-68)	1100*	2,306,000*

* Estimated Values

The values of the parameters of the least squares best-fit line were computed yielding

$$Y = \$291,730 + \$2,000(X)$$

A standard error of estimate, σ_y was computed to be $190,000.

Table 3

University	Students	Grants	Permissible Range
A	0	$ 292,000	+ $380,000
B	500	1,292,000	± 380,000
C	2,000	4,292,000	± 380,000

Table 3 shows how the calculation of grants might work if the historical pattern were considered acceptable for future applications. Three hypothetical universities are shown in separate stages of growth from 0 to 2000 students. Also shown is a possible range set at $2\sigma_y$ limits. This range could be considered as an adjustment zone for grant escalation or descalation based on factors peculiar to the university. We do not recommend this as a method but it is presented here simply to report an early phase of the analysis. Also, it is of some value for establishing a nominal value for a "set-up" cost of a new university.

The second phase of the historical analysis was concerned with relating income (and cost) per income unit to the number of income units. In the Ontario standard formula, one income unit is equivalent to one general arts or general science student. At the other extreme is the Ph.D. student who represents 6 income units. There are other weights which apply to courses taken by students falling within these two extremes. Thus, the number of income units accruing to a university depends on weighted student enrolment.

The standard formula applies to mature universities which have upwards of 1.5 income units per student. Universities having less than this ratio will find it difficult to develop academically, maintain quality and meet costs when supported only by standard formula grants and the earlier the university is in this development stage, the more difficult it will be for it to operate on standard formula. Thus, it appears that a formula for a developing university should provide for high support at inception with support per income unit decreasing until at some point in time and in weighted enrolment the university "emerges" and goes on standard formula.

Historical data were analysed to test this hypothesis. Data were taken from published information on grants to universities in 1966-67, UA3 forms submitted by all universities for reporting 1966-67 enrolment information and actual cost per unit information furnished by emerging universities.

Figure 4 contains the coordinates of income units and income per unit on arithmetic scale paper with a best-fit line drawn through the scatter of plots. Also shown on Figure 4 is tabular information

UNIVERSITY	ESTIMATED INCOME UNITS	INCOME PER UNIT	INCOME PER UNIT PER BASIC UNIT	COST PER UNIT	INCOME TO COST RATIO
TORONTO—ST. GEO.	33,377	1,165	1.01	1,232	0.946
WESTERN	13,937	1,092	0.950		
QUEENS	10,303	1,130	0.972		
McMASTER	9,143	1,210	1.050		
WATERLOO	10,125	935	0.865	1,278	0.78
CARLETON	5,844	1,247	1.080		
OTTAWA	10,021	970	0.845		
GUELPH	6,607	1,310	1.137	1,595	0.94
WINDSOR	4,337	1,120	0.971		
YORK	4,216	1,550	1.345	1,620	0.96
LAURENTIAN	1,626	1,490	1.295	1,710	0.87
LAKEHEAD	1,452	1,690	1.467	1,700	0.99
BROCK	655	2,940	2.550	3,870	0.76
TRENT	524	3,250	2.820	4,160	0.78
SCARBORO	597	3,091	2.685	3,250	0.95

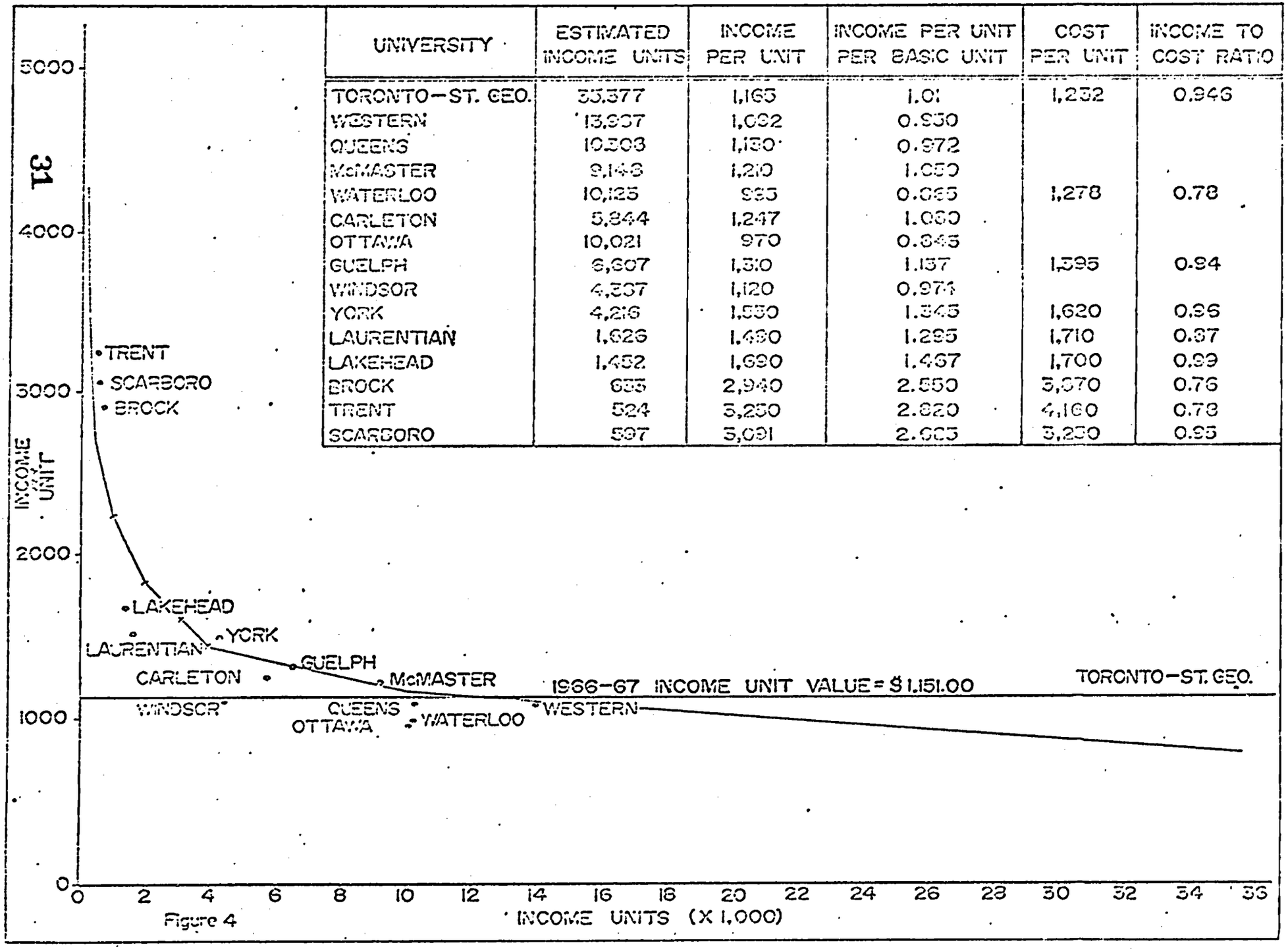


Figure 4

used to derive the scattergram (2nd and 3rd columns). The fourth column (ratio of income unit to the basic unit value) was derived by dividing each income per unit value by the reported value of the basic unit for 1966-67 ($1151). Next, cost per unit values supplied by emerging universities (Toronto also included for comparison) were compared to income per unit values to derive the last column - a measure of cost recovered by basic operating income. All values are approximate with calculations made by slide rule.

A best-fit line was constructed on log-log paper. The concept of the improvement curve applies here, so a least-squares line of regression of the form

$$Y = aX^{-b}$$

was calculated to be (in log form)

$$\text{Log income per unit} = 4.195 - 0.2821(\text{Log income units})$$

with a correlation coefficient of -0.87.

While the analysis showed the improvement curve to be applicable, the inclusion of mature university data introduced some bias. For the next analysis, 1966-67 income per unit data for only the seven emerging universities (Trent, Scarborough, Brock, Lakehead, Laurentian, York, Guelph) were regressed on corresponding numbers of income units on log-log paper to yield Figure 5. Leaving out the data from mature universities causes a steepening of the slope of the curve (as it should) and there is some improvement in the correlation coefficient to -.91. The values for the parameters log a and b, become respectively, 4.4487 and -0.36. This analysis is meaningful because it shows the emerging university income-per-unit

Figure 5

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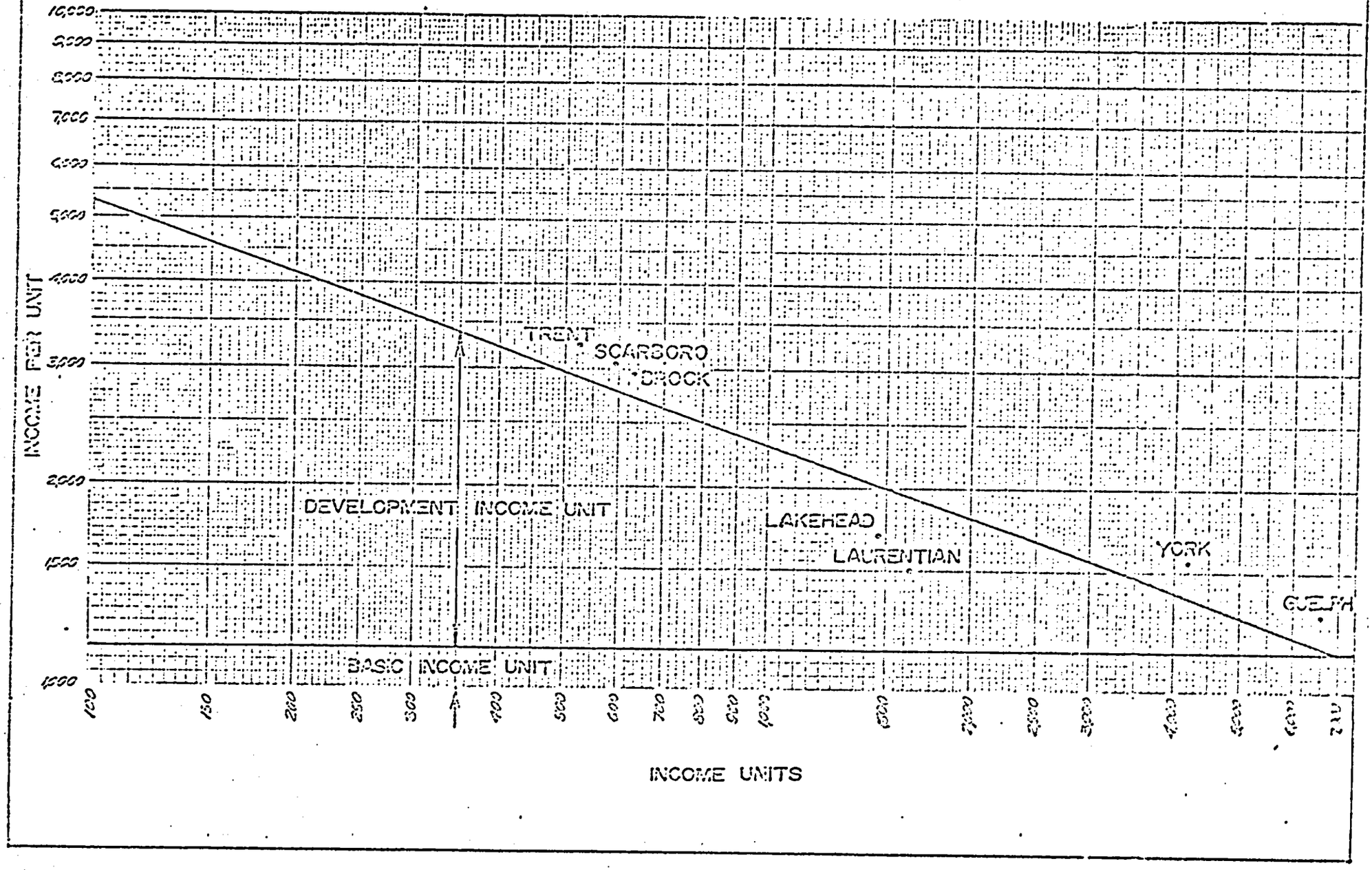
INCOME PER UNIT AS A FUNCTION OF INCOME UNITS

LOG Y = 4.4467 − .336 LOG X



line approaching the basic unit value line at a decreasing rate until it crosses over at about 7000 units.

Dealing with constant dollars only, it is permissible to partition the income unit value into standard unit value and development unit value and thence to the associated income values for various numbers of income units. Table 4 shows this partitioning process for a hypothetical university "emerging" at 5000 income units. For this hypothetical university we have arbitrarily placed the emergence point at 5000. Obviously it could be set at any number desired. Also, we have changed the slope slightly to provide more income early in the growth period.

The formula for the plan of Table 4 is

$$\log Y = 4.765 - 0.46(\log X)$$

Now, it is useful to graph the essential elements of this data to show peaking of the development line and ultimate convergence of this development line and the standard line.

Figure 6 is a graph of the data from columns (1), (5) and (7) of Table 4.

Development of the Formula

Figure 1 and Table 1 on pages E-4 and E-5 respectively are graphic and tabular representations of the formula which approximates the theoretically derived plan of Table 4 . The formula features two components - a basic component which applies to all universities (the standard formula) and a development component which applies

TABLE 4

Income Units (1)	Income per Unit (2)	Standard Unit Value (3)	Development Unit Value (4)	Standard Income (5) (1)x(3)	Development Income (6) (1)x(4)	Total Income (7) (5)x(6)
100	$7000	1150	5850	115,000	585,000	700,000
200	5100	1150	3950	230,000	790,000	1,020,000
400	3700	1150	2550	460,000	1,020,000	1,480,000
800	2700	1150	1550	920,000	1,240,000	2,160,000
1500	2000	1150	850	1,725,000	1,275,000	3,000,000
2000	1760	1150	610	2,300,000	1,220,000	3,520,000
3000	1460	1150	310	3,450,000	930,000	4,380,000
4000	1280	1150	130	4,600,000	520,000	5,120,000
5000	1150	1150	0	5,750,000	0	5,750,000

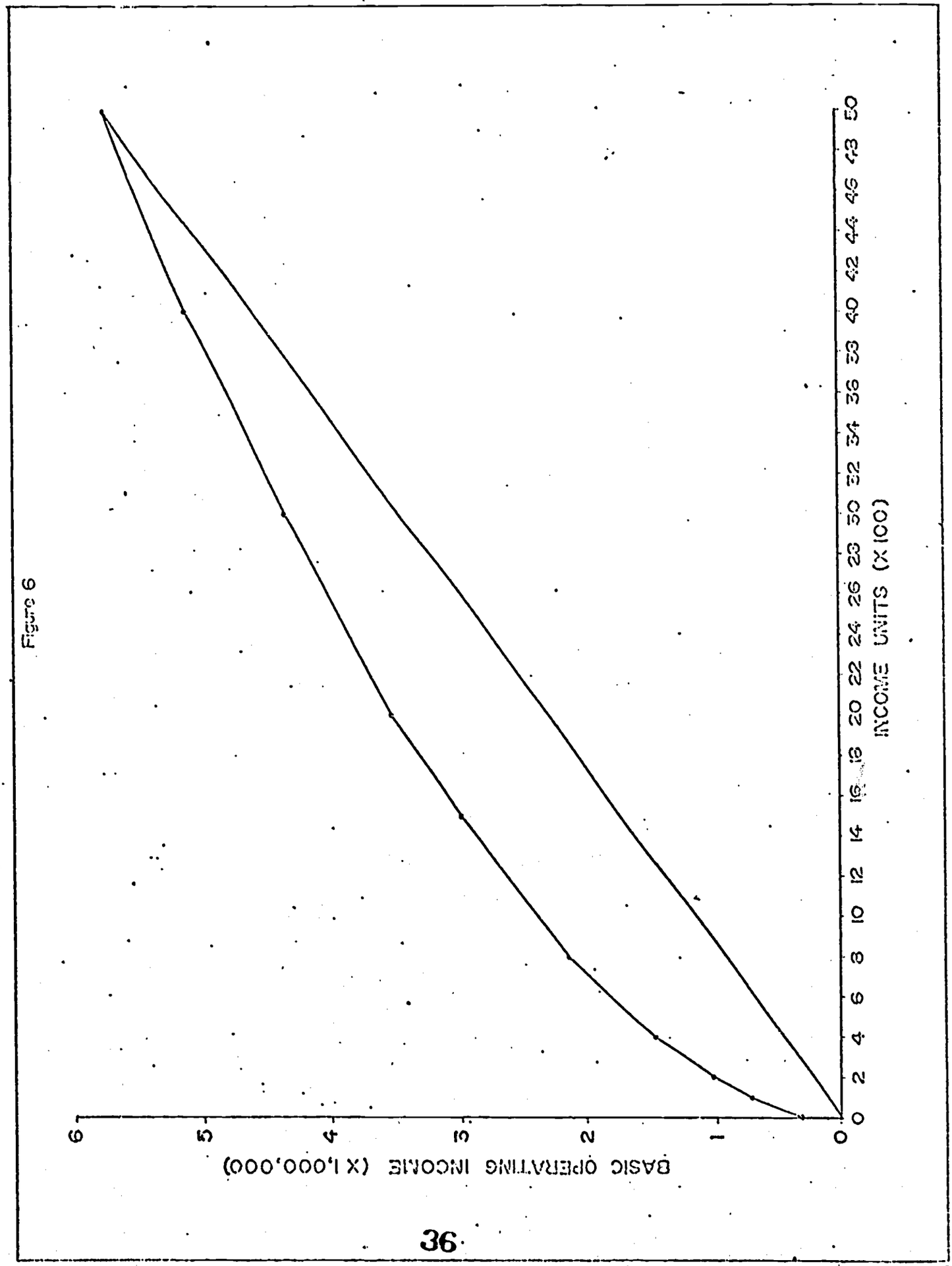

BASIC OPERATING INCOME (X 1,000,000)
0
1
2
3
4
5
6
INCOME UNITS (X 100)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50

Figure 6

only to emerging universities. The basic component is represented by a straight line extending from zero outward with a slope equal to unity; that is

$$Y = X$$

and

$$(A) = (B)$$

The development component is composed of two curves each having a different slope. The basic formula for the curves of Phases 1 and 2 is $Y = a + bx$

For a plan with Phase 2 terminating at 4000 units i.e., $(B)_x = 4000$

$$(A)_{\text{Phase 1}} = \frac{(B)_x}{8} + 2(B)$$

and

$$(A)_{\text{Phase 2}} = \frac{(B)_x}{2} + \frac{(B)}{2}$$

$$= \frac{(B)_x + (B)}{2}$$

Figure 7 was formed by applying a basic unit value of $1150 to the formula of Table 1 and superimposing the result on the curve of Figure 6.

In interpreting this it might be inferred that the formula is slightly more generous than the theoretical standard up to about 1800 units and progressively less generous from that point forward. Of course this results from forcing emergence at 4000 units. Changing the slope to reflect an emergence at 5000 units would cause the two standards to be quite similar.

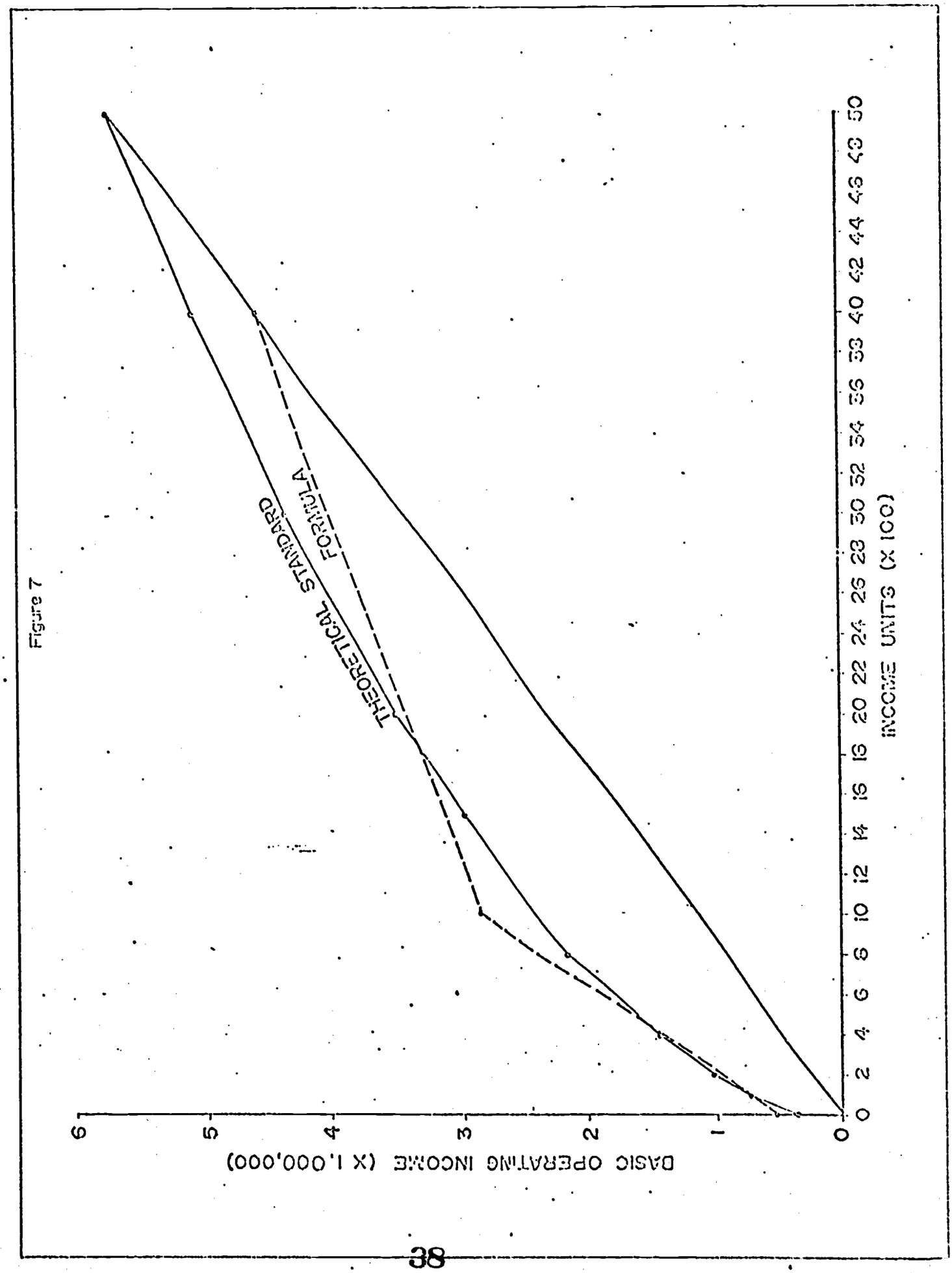

THEORETICAL STANDARD FORMULA
BASIC OPERATING INCOME (X 1,000,000)
0
1
2
3
4
5
6
INCOME UNITS (X 100)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50

Figure 7